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A Study on the Composite Teeth of Polyester Resin/Feldspar

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In this paper we describe an experimental study, reported in this article are trial manufacture of composite tooth material from unsaturated polyester as matrix and feldspar as filler and results of experimental studies in its mechanical properties, abrasion properties and cross linking effect by radiant rays, etc.

As a result of this series of tests and experiments, it was found that, as filler ratio increases, composite dental material of U.P./feldspar increases in elastic modulus but decreases in tensile strength, bending strength, elongation and deflection. Abrasion resistance becomes remarkably stronger as filler ratio becomes bigger. No radiation cross linking effects are expected. Material having feldspar by about 25% can be expected to be composite dental material.

1. INTRODUCTION

Composite material of resin and inorganic filler is considered to be one of the types of composite artificial teeth.[1] This composite artificial teeth have combined advantage of resin and inorganic filler for porcelain; viz. resin is cheap, easy to handle and superior in properties of adhesion, grinding, corrosion resistance and light in weight, while shortcoming of the resin in terms of abrasion resistance and hardness [2] can be compensated by inorganic filler for porcelain. Reported in this article are trial manufacture of composite tooth material from unsaturated polyester as matrix and feldspar as filler and results of experimental studies in its mechanical properties, abrasion properties,[4)~10),12)] cross linking effect by radiant rays, etc.

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2. EXPERIMENTAL PROCEDURES

U.P. is one of the most widely used resins for F.R.P.. Process of manufacture of U.P. is that unsaturated dibasic acid was esterized in the first place, either alone or in combination with saturated dibasic acid, under reaction temperature in the neighborhood of 200°C in inert gas such as carbonic acid gas or nitrogen gas; thence unsaturated alkyd, solid or viscous under room temperature, having 2,000-3,000 molecular weight and acid value of less than 50, was resolved into monomer together with a little quantity of polymerization inhibiter to obtain transparent liquid resin of lemon-yellow. This liquid resin is thermo-setting plastic which can be cured by adding polymerization starter.[3] Raw material of feldspar for porcelain teeth was ground to less than 60μ, and mixed with U.P. by 0, 25, 50 and 75 wt.%. It was then moulded by hot press for 40 minutes in 100°C under 115kg/cm^2 moulding pressure to prepare plate specimens, from which long rectangular test pieces of 50 x 10 x 2mm for No.2 Dumbbell test and abrasion resistance test were made by machine work. (Figs.1 and 2) Radiation cross linking effect was ascertained by giving tension test to test pieces exposed to irradiation of $Co^{60}\gamma$ ray by 10^5-10^7r. Abrasion condition was observed by scanning type electron microscope.

① : Specimen
② : Cylinder of mild steel
③ : Thermocouple
④ : Spring
⑤ : Recorder
⑥ : Differential transmission

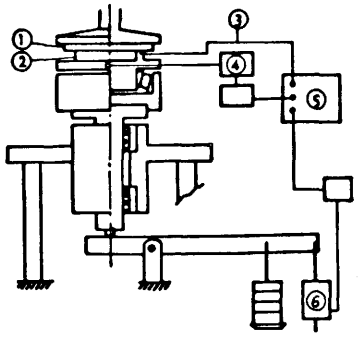


Fig.1 Schematic arrangement of the friction and wear test apparatus.

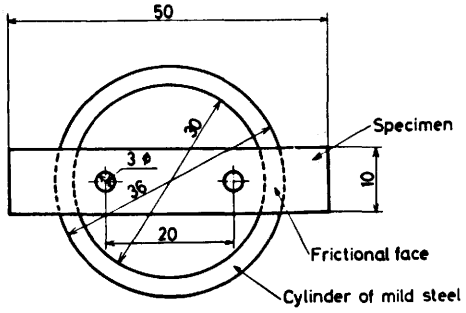


Fig.2 Dimension of specimen and cylinder of mild steel.

3. EXPERIMENTAL RESULTS AND CONSIDERATION

Relationship between mixing

ratio of U.P./feldspar composite dental material and tensile strength is shown in Fig.3, from which it is known that the more the filler be, the lesser in strength, and that when the feldspar content is 75%, the strength drops to 57% of that of U.P.. Fig.4 shows break elongation, and it is observed that elongation falls sharply as ratio of filler content goes up. When the feldspar content is 75%, elongation is only 18% of that of U.P.. Modulus of longitudinal elasticity is shown in Fig.5, from which it is observed that longitudinal elasticity increases almost linearly as filler content increases and that elasticity modulus

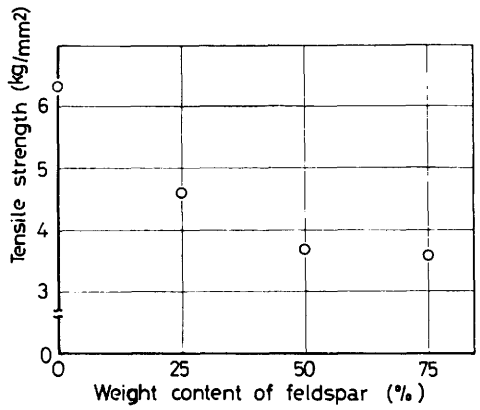


Fig.3 Relation between tensile strength and weight content of feldspar.

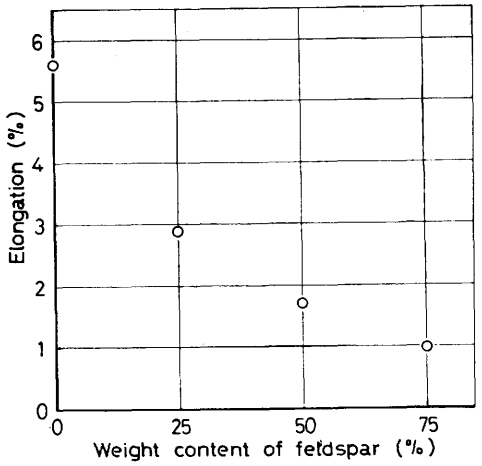


Fig.4 Relation between elongation and weight content of feldspar.

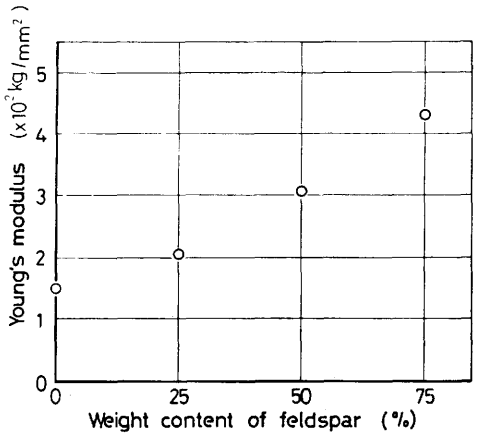


Fig.5 Relation between Young's modulus and weight content of feldspar.

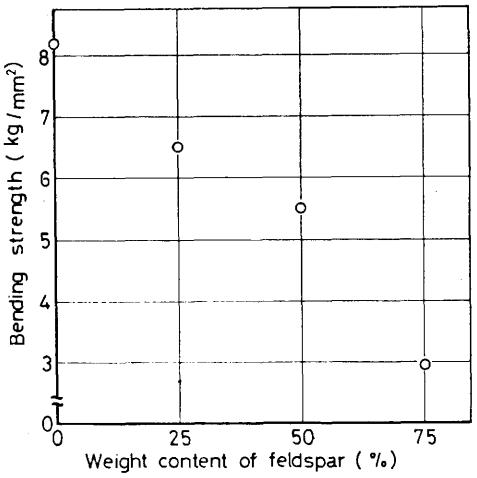


Fig.6 Relation between bending strength and weight content of feldspar.

of the composite material with 75% feldspar content is 2.9 times as much of that of U.P.. Fig.6 is the results of bending test: it is known that bending strength decreases sharply as feldspar content increases, thus the strength with 75% feldspar is 36% of that of U.P.. Deflection at the time of break is shown in Fig.7, from which it is observed that deflection decreases remarkably as feldspar content increases, so that deflection with 75% feldspar content is only 10% of that of U.P.. Fig.8 shows modulus of bending elasticity, and it is observed that the modulus of elasticity of the composite material was 7.2 times as much of that

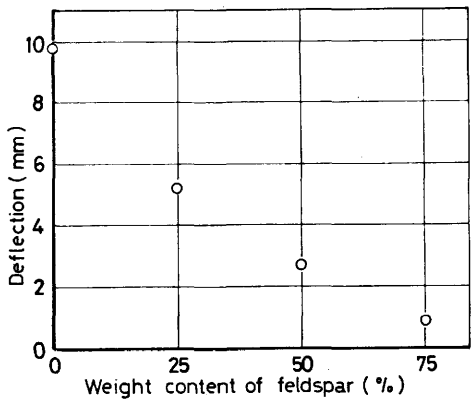


Fig.7 Relation between deflection and weight content of feldspar.

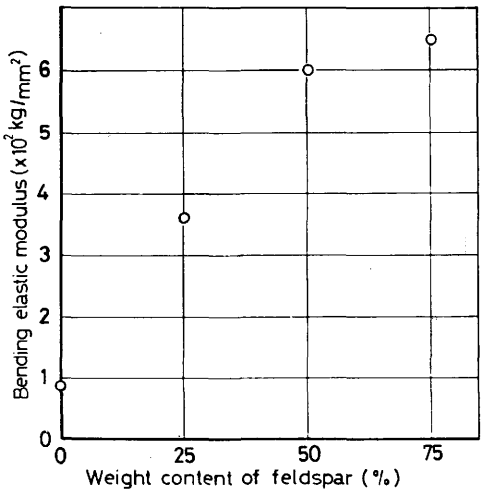
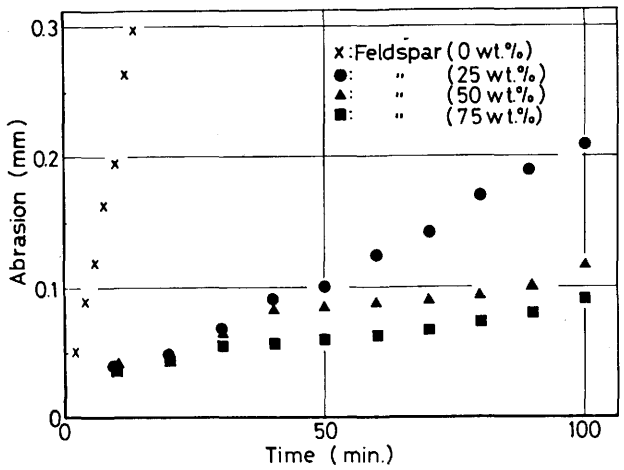


Fig.8 Relation between bending elastic modulus and weight content of feldspar.

Fig.9 Abrasion vs. time for unsaturated polyester/feldspar composite material; load, 12kg/cm^2; velocity, 52cm/sec.



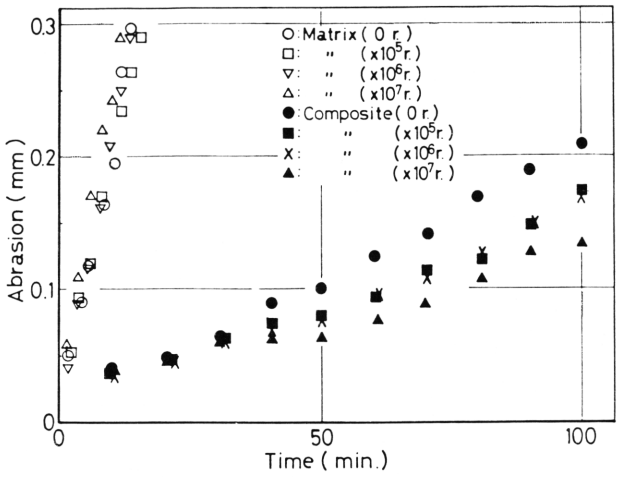
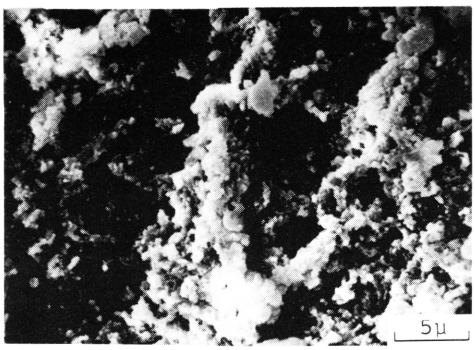
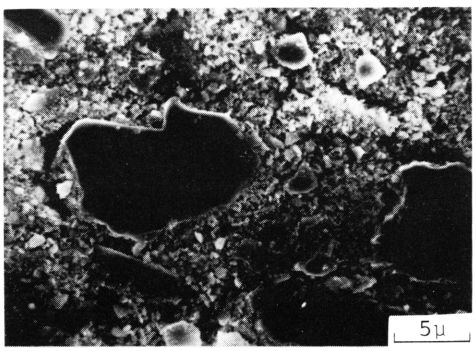


Fig.10 Abrasion vs. time for unsaturated polyester/feldspar composite material irradiated with $Co^{60}\gamma$ ray; load, 12kg/cm^2; velocity, 52cm/sec.

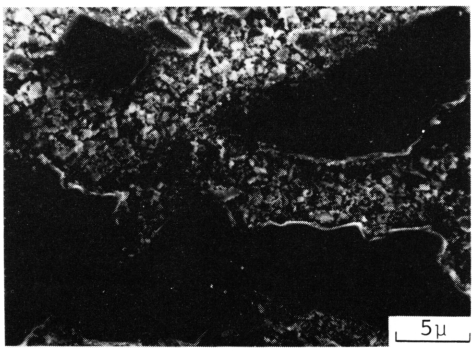


(a) Unsaturated polyester

(c) Unsaturated polyester/feldspar(50 wt.%) composite material



(b) Unsaturated polyester/feldspar(25 wt.%) composite material



(d) Unsaturated polyester/feldspar(75 wt.%) composite material

Photo.1 The appearances of abrasion surfaces of unsaturated polyester/feldspar composite materials.

of U.P., when the feldspar content is 75%. Fig.9 is the results of abrasion test of U.P./feldspar composite dental material, and it is known that abrasion resistance is improved remarkably as the feldspar content increases.[11] For example, irrespective of mixing ratio, abrasion of composite material after 10 minutes of abrasion time decreases to 1/5 of that of U.P. simple material. This tendency of decreasing in abrasion is enhanced as abrasion time becomes longer. Fig.10 shows results of abrasion test conducted with specimen irradiated with $Co^{60}\gamma$ ray, and it is noted that the results was quite similar to those shown in Fig.9. Through the observation of abrasion surface by scanning type electron microscope, it was known that abrasion of U.P. simple material progressed accompanying granular separate fracture. With regard to composite dental material, it is noted that U.P. wore first and feldspar so exposed has abrasion resistance.

4. CONCLUSION

The following summary can be made from the results of the present experiments. As a result of this series of tests and experiments, it was found that.

1) As filler ratio increases, composite dental material of U.P./feldspar increases in elastic modulus but decreases in tensile strength, bending strength, elongation and deflection.
2) Abrasion resistance becomes remarkably stronger as filler ratio becomes bigger.
3) No radiation cross linking effects are expected.
4) Material having feldspar by about 25% can be expected to be composite dental material.

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